TANDEM COMPRESSORS WITH DISCHARGE VALVE ON CONNECTING LINES

BACKGROUND OF THE INVENTION

[0001] This application relates to a shutoff valve placed on a connecting discharge line downstream of a compressor operating in a tandem compressor arrangement.

[0002] Refrigerant systems typically include a compressor delivering a compressed refrigerant from a compressor discharge port to a condenser, and then passing the refrigerant from the condenser to an expansion device, an evaporator, and then back to the compressor suction port. The load demand on the refrigerant cycle may vary. At times, there may be a need for a higher system cooling capacity and hence higher compressed refrigerant flow, and at other times, a lower cooling capacity and consequently lower refrigerant flow.

[0003] To provide continuous efficient supply of the desired amount of compressed refrigerant, some larger refrigerant systems utilize tandem compressors. In such systems, two compressors may simultaneously deliver a compressed refrigerant to a downstream heat exchanger, such as a condenser. Typically, fluid lines communicate with the discharge ports of the two compressors, and are merged into a single discharge line that sends refrigerant to the condenser. The system suction line is split in similar fashion into individual suction lines connecting to the suction port of each tandem compressor.

[0004] A control for such a tandem compressor system will operate one, or both of the compressors depending on system load. In situations where only one of the compressors is operational, the refrigerant can leak from a discharge line to suction line through the shutdown compressor. While the compressors are typically provided with a discharge check valve within the compressor shell, such check valves typically are not tight

enough to prevent such leakage. Further, under high pressure differential, such check valves may distort and become even less fluid-tight, or malfunction. Thus, the prior art tandem compressors, even the ones with check valves within the compressor shell can have substantial leakage losses and subsequent system performance degradation.

SUMMARY OF THE INVENTION

[0005] In a disclosed embodiment of this invention, a shutoff valve is placed on the connecting discharge fluid line leading from at least one of the compressors to the common connection point of all tandem compressors. Preferably, the shutoff valve is positioned outwardly of a compressor shell. More preferably, the two compressors are connected by a pair of fluid lines leading to a central line supplying the downstream heat exchanger (e.g., the condenser).

[0006] A control for the shutoff valve may close a valve, blocking flow of refrigerant from an operational compressor from leaking through the discharge chamber of a non-operating compressor.

[0007] The present invention provides benefits in that it eliminates leakage losses that would otherwise occur in a tandem compressor arrangement having one compressor shutdown. Furthermore, continuous high pressure differential across the check valve will be eliminated as well.

[0008] These and other features of the present invention can be best understood from the following specification and drawings, the following of which is a brief description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Figure 1 shows a prior art compressor system.

[0010] Figure 2 shows the inventive compressor.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0011] Figure 1 shows a prior art refrigerant system 20 incorporating a pair of tandem compressors 22 and 24. As shown, the compressors 22 and 24 are preferably scroll compressors.

[0012] The compressors are provided with discharge ports (tubes) 51 and 52 that form a part of respective flow connecting discharge lines 28 and 30 leading to a central connecting discharge line 27 that communicates compressed refrigerant to condenser 26. From the condenser 26, refrigerant passes to an expansion device 32, and to an evaporator 34. From the evaporator 34, the refrigerant returns through common suction line 39 that branches off to individual suction lines 36 and 38 to the interior shell of each compressor.

[0013] As is known, an upper part 41 of the compressor is at a discharge pressure. A check valve 42 is typically placed such as in a separator plate 43 within the scroll compressor.

[0014] In the prior art, a control for the tandem compressors may shutdown one of compressors 22 and 24 when a lower demand for cooling capacity is present and hence lower refrigerant flow is desirable. Say that compressor 22 is shutdown. Now, compressor 24 is delivering compressed refrigerant to line 28 and consequently to line 27, since they are in direct communication with each other. However, a portion of this compressed refrigerant can undesirably pass through line 30 back into the discharge chamber 41 of the compressor 22.

While check valve 42 will resist flow somewhat, these check valves may be inherently leaky allowing refrigerant to bleed at shutdown. Thus, some of the compressed refrigerant flowing from line 30 into chamber 41 will bleed past the check valve 42 directly to compressor 22 and refrigerant system 20 suction side. This high to low leak is undesirable and leads to system performance loss.

[0015] Thus, the present invention provides a control 43 for operating the two compressors 22 and 24. Control 43 further controls a pair of shutoff valves 44 and 46. While it is desired that both lines 30 and 28 have a shutoff valve, it is within the teachings of this invention that only one of the two lines be provided with a check valve, since in many occasions, a specific compressor(s) is(are) dedicated for part-load operation while the other one(s) is(are) being shutdown.

[0016] Now, if the control 43 determines that only one compressor operation is necessary, the shutoff valve 44 or 46 associated with the other compressor is closed, and this other compressor is shutdown. Then, as the compressor (say 24) continues to operate, compressed refrigerant is delivered from compressor discharge port 51 through line 28, to line 27, and to condenser 26. There will be no leakage losses through the line 30, as shutoff valve 46 will be closed to block such leakage.

[0017] Furthermore, continuous high pressure differential across the check valve will be eliminated as well.

[0018] An additional advantage of having a leak-tight valve located on the compressor discharge line is that fluid migration from the condenser into the compressor is prevented. This alleviates the possibility of having a flooded compressor at startup.

[0019] The shutoff valve, for example, may be a controlled solenoid valve, or may be a very fluid-tight check valve or any other type of valve. If a solenoid valve is utilized, most preferably it will be a valve that is biased to a normally open position such that upon failure, there is no restriction to flow through the shutoff valve. Furthermore, if a solenoid valve is employed, it will be opened shortly before the compressor start-up to prevent flow blockage in discharge line when the compressor is started.

[0020] While the present invention has been disclosed in a conventional air conditioning system, it should be understood that the invention would also extend to a heat pump having both cooling and heating modes. In a heating mode, the flow of refrigerant would be initially to the heat exchanger 34, which is an evaporator in the cooling mode, but is more generically an indoor heat exchanger. Some modification of the system would be necessary to achieve this dual flow, however a worker of ordinary skill in the art would recognize how to provide such flow management.

[0021] Furthermore, although the invention primarily describes scroll compressors, other compressor types, such as screw, rotary, etc., may benefit from the teachings of this invention as well. Also, a number of compressors in the tandem arrangement can be extended indefinitely with the shutoff valves placed on a discharge side of the compressors that will be shutdown during part-load operation.

[0022] Finally, it should be noted that tandem compressor arrangement may include an oil equalization line, connecting oil sumps of the tandem compressors, for oil management and a vapor equalization line, connecting shells (low pressure side) of the tandem compressors for pressure equalization.

[0023] Although a preferred embodiment of this invention has been disclosed, a worker of ordinary skill in this art would recognize that certain modifications would come within the scope of this invention. For that reason, the following claims should be studied to determine the true scope and content of this invention.